



Lithic tool management in the Early Middle Paleolithic: an integrated techno-functional approach applied to Le Pucheuil-type production (Le Pucheuil, northwestern France)

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ABSTRACT

The significant development of predetermined flake technologies marks the beginning of the Middle Paleolithic in Europe. This phenomenon is not only expressed by the increase in the Levallois methods, but it also includes a diversity of other flaking methods, e.g. micro-Levallois, Kombewa, truncated-faceted and Le Pucheuil, often related to secondary reduction sequences. The tool management and use patterns they fulfill are still largely unknown due to the scarcity of use-wear analyses, whereas their technological characteristics are well defined.

In this paper we present a combined technological and functional study of Le Pucheuil-type flakes (Delagnes, 1993), from the eponymous Early Middle Paleolithic site of Le Pucheuil (northwestern France). The technical investment during the reduction sequence is relatively low but flaking is nevertheless guided by specific and constant technical rules which result in the production of predetermined flakes. These flakes share common morphotechnical attributes: an acute, straight or slightly curved, distal edge opposed to a robust and wide proximal area. The use-wear analysis shows that this morphology was clearly sought after insofar as the distal acute edges were used as working edges while the proximal edges served as prehensile areas. Despite their similarity, Le Pucheuil-type flakes were used for a variety of tasks, including butchery but also hide scraping, wood and non-woody plant working. Tool management suggests that their production responded to deferred and/or collective uses. Our combined approach points to: 1. the high degree of elaborateness and flexibility of the tool management strategies developed in the Early Middle Paleolithic in Europe, 2. the presence of long-lasting and multi-activity occupations in an open-air context during the harsh environmental conditions at the beginning of the penultimate glaciation (OIS 6). The results finally show the great potential of combined technological/functional approaches to lithic assemblages as a way to refine our understanding of the technical, social and economical organization of Neanderthal hunter-gatherers, most specifically in contexts where lithics are the only preserved materials.

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1. Introduction

Lithic tool production and use patterns are highly informative of the organizational strategies of Paleolithic hunter-gatherers. They are particularly critical for the Early Middle Paleolithic as this period saw the emergence of a variety of knapping methods aiming at producing predetermined blanks (Delagnes and Meignen, 2006; Richter, 2011). Assessing the advantages and behavioral

implications of such new technological strategies is however constrained by the fact that significant parts of the lithic *chaînes opératoires*, and in particular the use stages, are very poorly documented (Beyries, 1987; Geneste and Plisson, 1996). This is mainly due to the scarcity of available use-wear data for this time period, best explained by the poor preservation of traces.

This paper addresses the issue of the behavioral complexity that characterizes the Early Middle Paleolithic period in Europe via an integrated technological and use-wear analysis of the lithic assemblage from Le Pucheuil, Series B (Delagnes and Ropars, 1996), located in northwestern France. A thorough reconstitution of the lithic *chaînes opératoires* has been performed from the first stages of lithic production to tool use and discard. The Pucheuil B assemblage

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responds to a dendritic *chaîne opératoire* divided into an elaborate primary reduction sequence and a number of much more simple secondary reduction sequences, commonly recycling by-products from the primary production and which result in distinct end-products (Delagnes, 1993). This article aims to specify the role of these secondary productions, usually regarded as expedient, in the technological strategies that emerge during the early phases of the Middle Paleolithic. We will more closely explore Le Pucheuil-type secondary production, which is devoted to the obtention of a unique type of predetermined flake, called Le Pucheuil-type flake, for on-site use. The high-resolution data provided by refits and the use-wear analysis of a large lithic sample gives an accurate picture of Neanderthal technological, social and economic organization in the harsh environment of an open-air loessic context at the beginning of MIS 6 penultimate glacial period.

2. Background

The clear development of predetermined flake technologies marks the beginning of the Middle Paleolithic in Europe. This phenomenon is not only expressed by the increase in the Levallois methods, but also includes a diversity of other flaking methods, eg. micro-Levallois, Kombewa, truncated-faceted and Le Pucheuil-type, often related to secondary reduction sequences. The tool management and use patterns they fulfill are still largely unknown due to the scarcity of use-wear analyses. Functional analysis of Lower and early Middle Paleolithic assemblages are driven by a long tradition of research in western Europe since the pioneer works of L.H. Keeley (1980), P. Anderson (Anderson-Gerfaud, 1981) and S. Beyries (1987). However, traceological analysis of collections from the Lower and Middle Paleolithic is not an easy task. Taphonomic processes and post-depositional agents produce surface modifications. Some of them alter use-wear traces, especially micropolishes and striations, to the extent that they conceal or totally remove them, or misinterpreted as use-wear traces instead of alteration forms (Levi-Sala, 1986; Plisson, 1986; Plisson and Mauger, 1988; Beyries, 1993; Coffey, 1994; Caspar et al., 2003).

Fortunately, acquired experience in these issues by the discipline alleviates the situation through: (1) wider knowledge and growing reference frameworks on taphonomic alterations (Plisson, 1986; Knutsson, 1988; Knutsson and Lindé, 1990; Shea and Klenck, 1993; Coffey, 1994; Clemente, 1995; McBrearty et al., 1998; Caspar et al., 2003; Pargeter, 2011), (2) the combination of different types of use-wear traces, addressing distributions and associations of traces in particular thus providing more robust patterns of inference (González-Urquijo and Ibáñez, 1994), (3) and refinement in observational and recording devices and systems (Plisson and Lompré, 2008; van Gijn, in press).

In fact, use-wear analyses of collections with close chronologies to Pucheuil B are scarce (Fig. 1) and they are furthermore limited to small samples, rarely exceeding few tens of artifacts. They refer to Grotte Vaufrey level VIII (Beyries, 1987), Biache-Saint-Vaast, level IIA (Beyries, 1988; Rots, 2013), Maastricht-Belvedere sites C and F (Van Gijn, 1989), Les Tares (Geneste and Plisson, 1996), Remicourt-En Bia Flo (Bosquet et al., 2004), Coudoulous (Jaubert et al., 2005), Hermies (Vallin et al., 2006), Cova 120 Levels IV to VII (Terradas and Clemente, 2011), Lezetxiki level VI (Lazuén and Altuna, 2012; Lazuén, 2012b) and Spy (Jungels et al., in press). The results of these analyses reveal a rather wide range of activities carried out by European Neanderthal groups in the OIS 7/6 period. Identified tasks include hunting with specialized tools, transformation of wood products, non-woody material procurement, hide-working, and butchering related to different phases of animal carcass processing. Despite this wide variability of identified tasks, most studies suggest that animal butchery is by far the main activity at occupations

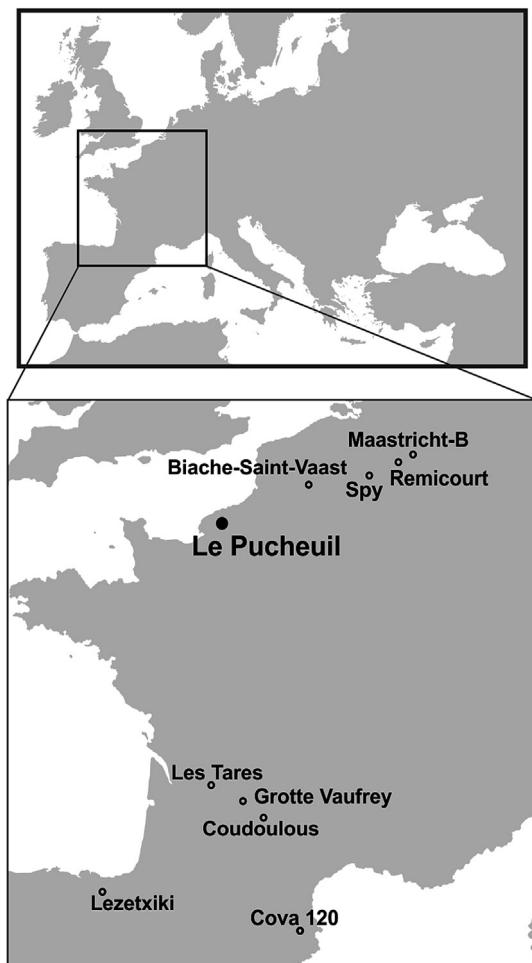


Fig. 1. Early Middle Paleolithic sites in Western Europe with use-wear analysis cited in the text.

in this region and period. In general, it is difficult to see any clear relationship between tool types and the tasks they are involved in, beyond a significant association between unretouched flakes and butchery (González-Urquijo and Lazuén, 2013).

3. Methods and materials

Le Pucheuil is an early Middle Paleolithic open-air site, situated in northwestern France close to the village of Saint-Saëns, in the heart of the Pays de Caux, a chalky plateau in Upper Normandy belonging to the Parisian Basin (Fig. 1). The site was excavated in 1990 and 1991 under the direction of A. Ropars as part of a salvage archeology operation prior to the development of a motorway. Studies on the site's archeology (Ropars et al., 1996), geomorphology and chronostratigraphy (Halbou and Lautridou, 1996), site formation processes (Delagnes et al., 1996) and lithic technology (Delagnes, 1996a, 1996b) were extensively published in a monograph (Delagnes and Ropars, 1996). Two human occupations were identified at this site within the context of a doline. The first (Series A–C) occurred on the plateau, before the formation of the doline at the very end of OIS 8 or beginning of OIS 7, c. 250,000 BP, while the second occupation (Series B) took place after a first phase of doline formation, at the beginning of OIS 6, c. 200,000–180,000 BP. This paper focuses on the second occupation phase (Series B), which was preserved over a total surface of c. 100 m² within a thin silt deposit, 10–15 cm thick, rich in lithic artifacts. The excavations of Series B

focused on a 32 m² area, complemented by a 20 m² area where the lithics were all collected but not plotted.

Only lithics ($n = 4111$) were preserved within the deposit. They formed marked concentrations, slightly displaced down the c. 5° doline slopes, as a result of subsequent doline collapses. These concentrations corresponded initially to knapping spots, as evidenced by the spatial distribution of the main refitted sets (Delagnes, 1996a). The technological analysis is based on the information provided by the refits, which account for some 31% of all lithics larger than 2 cm ($n = 709/2301$) and 52% of the assemblage total weight (16.5/31.5 kg), with most of the refitted pieces included in 9 main refits of over 15 items. These refits have played a pivotal role in the dynamic *chaînes opératoires* reconstruction, via a piece by piece and stage by stage (e.g. platform preparation) analysis of the refitted items following the core reduction chronology. Additionally, all non-refitted items that belong to the same flint nodule, on the basis of the flint color, texture, inclusions and cortex, were included in the analysis, allowing a detailed assessment of the missing products and of the reduction stages that occurred off-site for each nodule. The analysis of the *chaîne opératoire* thus combines a direct reading of the successive phases of core reduction via the refits (eg. Pigeot, 1987, 1990), an assessment for each nodule of the related core *débitage* strategies and portions of the reduction sequences that are missing (an approach known as minimal analytical nodule analysis or MANA as defined by Larson and Kornfeld, 1997), and a technological analysis that follows the classification system into concepts and methods as defined in particular by E. Boëda (Boëda, 1995; Boëda et al., 1990; Delagnes and Meignen, 2006). These combined approaches were able to address a number of questions which are recurrent but rarely tackled directly in the Middle Paleolithic record. Among them is the issue of the co-existence of diverse reduction strategies within a single archaeological layer: multiple occupational events or a single multi-activity occupation involving a wide array of technical practices?

The use-wear analysis was performed by combining a reflected light microscope (metallurgical) Leica DM2500M, bright field, with magnifications from 50× to 500× for the striation, polishing and micro-rounding characterization and a macroscope Leica Z16 Apo with a zoom to 115× mainly for fractures and macro-rounding.

Functional interpretations are based on the identification of a use-wear pattern: polishing, striations, rounding, microfractures and rarely residues, together with their position, distribution and association. These identification patterns are built upon

experimental programs that were elaborated in the 1980s and 1990s inspired by the work of S.A. Semenov (Semenov, 1964; Keeley, 1980; Mansur-Franchomme, 1983; Vaughan, 1985; Plisson, 1985; Beyries, 1993; González-Urquijo and Ibáñez, 1994). Observational training and criteria are based on an extensive reference experimental program (González-Urquijo and Ibáñez, 1994; Lazuén, 2012a).

The resulting criteria are as follows (Table 1, modified from González Urquijo and Ibáñez, 1994). For micropolish: microtopography (smooth, undulating), pattern or weave (open, closed, etc., near coalescence concept of Plisson, 1985), cross-linking (size of weave in open or semi-open patterns), surface accidents (crackled, holes), degree of development, distribution (along edges), extension on edge, invasiveness, location (relation between faces of the edges), and presence of linear features. We do not consider shine, an extended criterion, as an independent trait since it is a function of microtopography and pattern. For striations: type, length, width and depth, orientation/direction, distance to the edge, and quantity. For rounding: degree of rounding, extension on edge and location, i.e. symmetry on edge. For microscars, relative quantity (number per cm), location (i.e. uni- or bi-facial), distribution, disposition (relation among scars: isolated, superimposed), morphology, size and termination (feather, stepped). Particular attention is given to the overall patterning and the relation between different traces, especially the spatial relationships between micropolish and scars.

4. Results

At Le Pucheuil, five reduction sequences have been identified and partly refitted (Delagnes, 1996a): a Levallois preferential/recurrent unidirectional convergent sequence ($6 < n < 10$ nodules), a unidirectional production of flakes according to a method called Le Pucheuil-type flaking method (≥ 6 nodules), a unidirectional production of elongated flakes on the narrow face of the cores (≥ 3 nodules), a Levallois recurrent centripetal sequence ($n = 1$ nodule), and a bifacial shaping sequence ($n = 1$ nodule) (Table 2). The last two correspond to independent reduction sequences performed on distinct flint nodules, and could be the result either of a unique occupational event or of two distinct ones. The main reduction sequence, based on a Levallois recurrent unidirectional convergent method, was devoted to the production of end-products: Levallois points and triangular flakes. This primary sequence also provided a number of by-products, i.e. bulky flakes and chunks and Levallois

Table 1

Summary of microscopic criteria for functional interpretation (modified from González-Urquijo and Ibáñez, 1994).

Micropolish	Microtopography	Microscars	Morphology	Overall patterning
	Pattern/weave		Termination	
	Cross-linking		Disposition	
	Surface accidents		Size	
	Degree of development		Distribution along edge	
	Distribution –along edges		Location (uni- or bifacial)	
	Extension on edges		Quantity / density	
	Invasiveness			
	Location			
	Linear features			
Striations	Type	Rounding	Degree	
	Size: length, width, depth		Extension	
	Orientation /direction		Location (symmetry on edge)	
	Distance to edge			
	Quantity / density			

Table 2

Composition of the lithic assemblage from Le Pucheuil – B (all lithics > 2 cm).

All reduction sequences	N Refitted	% Refitted	N Total
Whole cobbles	0	—	2
Hammerstones	0	—	1
Cortical flakes	0	—	517
Unspecific flakes	0	—	1205
Unspecific core management flakes	0	—	335
Unspecific cores	0	—	18
Core fragments	0	—	4
Chunks	0	—	1219
Levallois unidirectional convergent débitage			
Levallois points	3	—	10
Unidirectional convergent Levallois flakes	29	23.2	125
Core management flakes	53	37.3	142
Unidirectional convergent Levallois cores	6	—	7
Le Pucheuil-type débitage			
Le Pucheuil-type flakes	66	41	161
Le Pucheuil-type cores	28	73.7	38
Laminar débitage			
Core management flakes	5	—	7
Elongated flakes	13	—	16
Laminar cores	3	—	3
Levallois recurrent centripetal débitage			
Core management flakes	20	—	28
Levallois recurrent centripetal flakes	4	—	6
Bifacial shaping			
Shaping flakes	21	7.9	265
Fragments of bifaces	0	—	2
Total	712	17.3	4111
Retouched tools	0	—	14

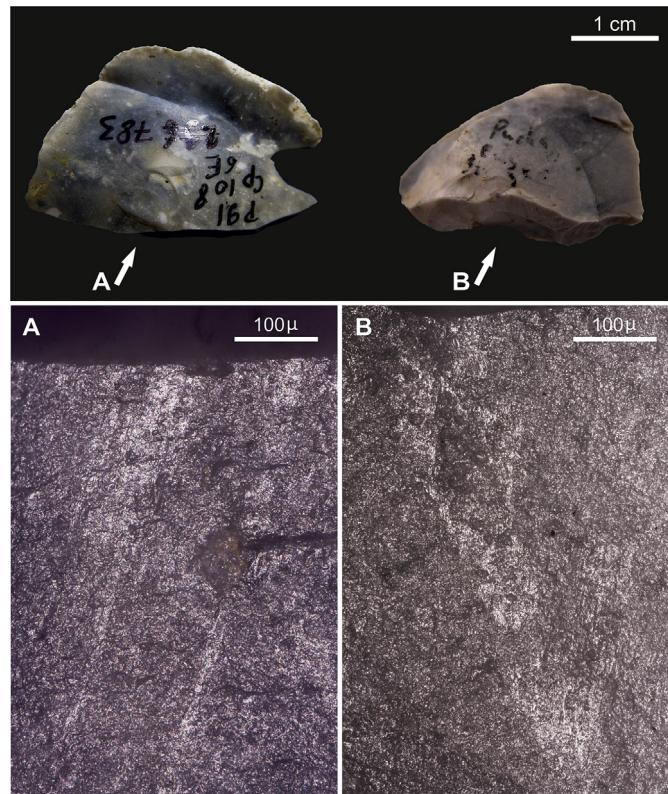


Fig. 3. Percussion traces. Striations and linear polish (A & B) on the butt of the flakes caused by contact with a hard hammer. Incident light microscope, 100×. Top, position of the photographed zones.

cores, which were recycled as cores for the two secondary -Le Pucheuil-type and elongated flake-productions. These reduction sequences form part of a *dendritic chaîne opératoire* (Fig. 2) which was very probably performed during a single occupational event.

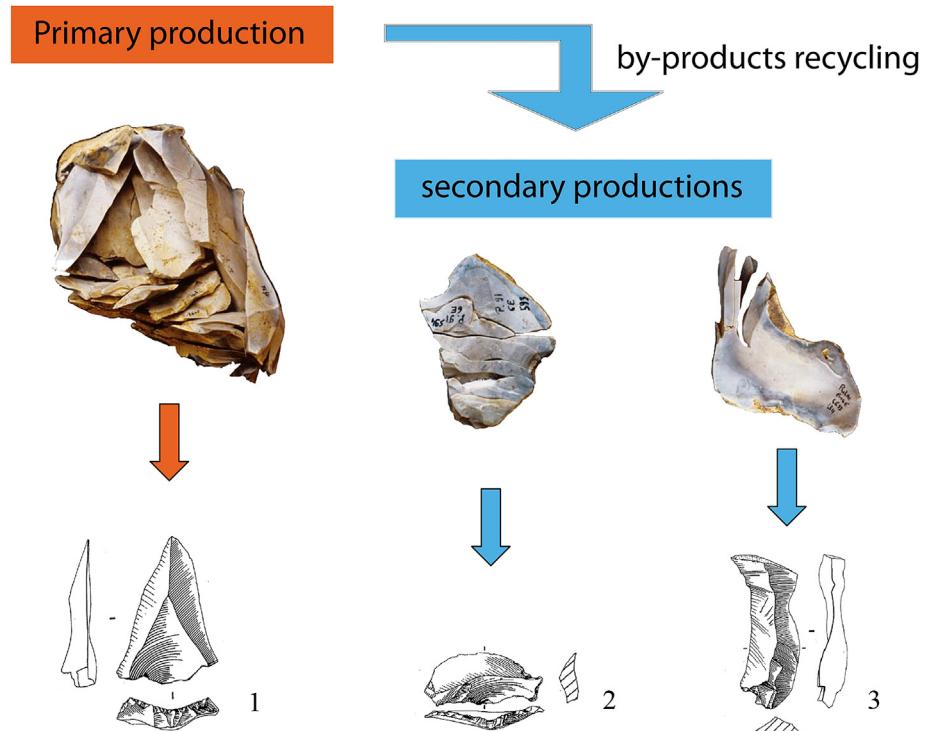


Fig. 2. Dendritic *chaîne opératoire* of le Pucheuil B assemblage, illustrated by three refitting sets. The primary reduction sequence (1), based on a Levallois unidirectional convergent method, is performed from the first stages of core volume preparation to core abandonment, while the two secondary – Pucheuil-type (2) and elongated flakes (3) – reduction sequences are performed from by-products issuing from the primary reduction sequence.

This study focuses on the production, management and use of Le Pucheuil-type flakes. The Pucheuil type production is represented by a total of 199 products (38 cores, 161 flakes), a high proportion of them ($n = 66/161$, i.e. 47%) included in refits. These proportions indicate that this production was largely performed and used on-site. The technical principles are quite simple (Delagnes, 1993), based on a recurrent unidirectional flaking method performed with a direct hard-hammer percussion technique, also observed via microscopic traces (Fig. 3). As documented by the refits, the cores were selected from among the by-products of the main Levallois unidirectional convergent reduction sequence, and these may be flakes, chunks or cores, in essence any bulky blank displaying an extended flat surface. The production of flakes is performed on the unprepared flat surface of the core. Core preparation is limited to the preparation of a convex or V-shape faceted platform on a small portion of its periphery. Platform preparation is very minimal at the beginning of the reduction sequence and becomes more and more elaborate as the débitage progresses, with fine faceted extended platforms, while the flaking surface is kept unprepared. All the flakes are extracted from a single platform, with each flake superposed on the previous one and more invasive so that its distal edge cuts the flat knapping surface of the core. The first flakes are extracted according to fracture planes that are sub-parallel to the flaking surfaces, while the following flakes display in profile fracture planes that become progressively more and more oblique (Fig. 4). The series consist of two to eight successive flakes. Several independent series of flakes have sometimes been produced from a single core.

Predetermination does not refer here to a high investment in core preparation and management, as observed for the primary Levallois reduction sequence. It relates to specific and constant knapping rules in core reduction, which result in the homogeneous morpho-functional attributes of the flakes that are clearly intentional. The flakes are thin, wide and short. The proximal part is formed by a wide butt opposed to a wide distal cutting edge. Their lateral edges are short, and can be straight or convex. In profile, the previous flake negative forms a marked concavity at the bottom that is contiguous to a straight distal plane created by the portion of the core surface removed by the flake. The distal edge ends in an acute angle of normally between 30 and 40°. Le Pucheuil-type

Table 3

Worked materials and tasks performed. Numbers count the total active areas ($n = 71$, for 70 utilized flakes).

	Scraping	Cutting	Mixed	Indet.	Total	%	%	%
Butchery		9			9	12.7	15.5	28.1
Bone	2				2	2.8		
Hide	5				5	7	12.6	
Dry hide	4				4	5.6		
Wood	2	2			4	5.6	19.6	
Wood/Non-woody plant	4	1			5	7		
Non-woody plant	3	1	1		5	7		
Soft material	4	9			13	18		
Soft/medium material	2	3			5	6.9		
Medium material	4				4	5.6		
Hard material	3				3	4.2		
Indeterminate	8	2	1	1	12	16.7		
Total	41	27	2	1	71			

flakes were never intentionally modified with retouch. The functionality of the tool is based on a wide proximal prehensile area opposed to a wide distal working edge, or transformative part *sensu Boëda* (Boëda, 1997). But do these specific and constant attributes relate to specific activities? And what do they tell us about the function of this open-air site?

Use-wear analysis has been performed on 135 out of a total of 161 Le Pucheuil-type flakes, as a result of an initial selection which excluded flakes with macroscopic alterations. An additional control sample of 4 Pucheuil cores has been studied. Therefore, the total sample includes 139 implements.

The general state of preservation of the selected sample is acceptable, although some flakes ($n = 22$, 16%) are heavily affected by patination, soil luster or mechanical friction (Levi-Sala, 1986) that prevent an adequate microscopic analysis. The low displacement of the artifacts and the fine-grained sediments, coupled with a rapid infilling of the doline, could explain the generally good state of preservation of the lithic tools. It should be noted that the most altered items were located in the upper part of the deposit, probably more affected by freezing. The slope of the doline (c. 5°) probably favored a slight displacement of the artifacts downwards, which had no visible mechanical effect on the flake edges. 70 out of

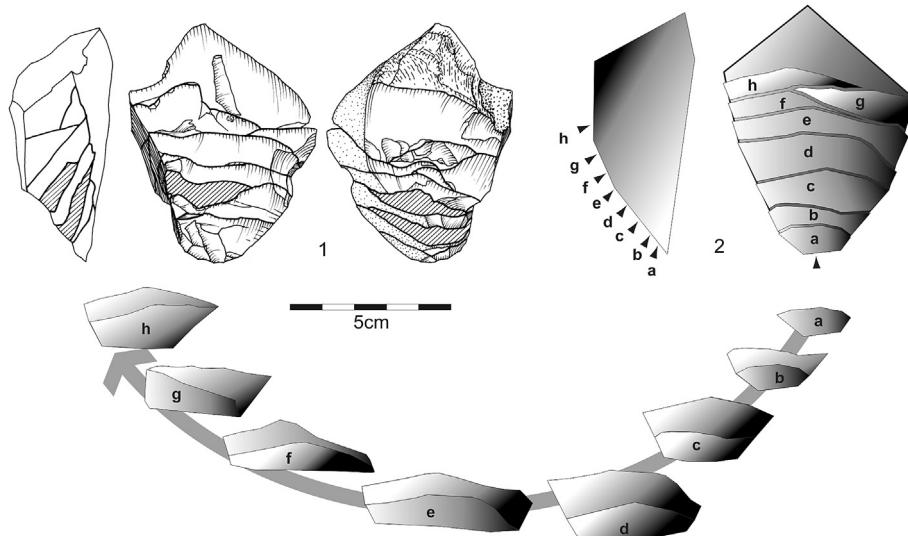


Fig. 4. Technological principle of the Pucheuil type débitage; 1. Refit of a series of 8 Pucheuil type flakes and resulting core, belonging to a larger refitted set (refit 6: 75 refitted products) that evidences the exploitation of 9 by-products into Le Pucheuil type cores, from a cobble initially used for the Levallois unidirectional convergent débitage; 2. Schematic reconstitution of a Pucheuil type reduction sequence.

Table 4

List of observed use-wear traces.

Number	Tool	Flake edge	Observations	Interpretation of action	Interpretation of material worked	Interpretation of activity
1	Puch 379	Distal	Bifacial discontinuous scars, 0.1–0.4 mm; discontinuous micropolish band, max. 200 μ ; long parallel striae	Cutting	Flesh (few bone contact)	Butchery
2	Puch 124	Distal	Unifacial (dorsal) scars; marginal (30 μ) very developed polish; some transversal striae	Scraping	Non woody plant/wood	Scraping rigid non woody plant/wood
3	Puch 2770	Distal	Very few scars; continuous, marginal micropolish on ventral face	Scraping	Undetermined	Scraping undetermined material
4	Puch 2762	Distal	Bifacial scars (more on ventral face) < 0.4 mm; undulating, semiopen pattern micropolish, more extended (100 μ) in central segment of the edge; long parallel striae	Cutting	Non woody plant/wood	Cutting non woody plant/wood
8	Puch 2394	Lateral (left) & proximal	Small unifacial (ventral) scars; polish extended to ~50 μ , irregular microtopography; slight rounding	Scraping	Dry hide	Scraping dry hide
8	Puch 2394	Distal	Small unifacial scars (ventral face). Dull, irregular surface polish. Slight rounding	Scraping	Dry hide	Scraping dry hide
9	Puch 550	Distal	Continuous, unifacial microscarring <0.2 mm on dorsal. Isolated micropolish areas mostly ventral	Scraping	Undetermined	Scraping undetermined
10	Puch 655	Distal	Small discontinuous scars on dorsal. Dull, irregular surface polish without appreciable rounding	Scraping	Hide	Scraping hide
15	Puch 3110 208	Distal	Discontinuous bifacial scars <0.25 mm. Micropolish slightly developed on both faces	Cutting	Soft material	Cutting soft material
16	Puch 277	Distal	Discontinuous bifacial scars, some >0.5 mm. Well developed marginal micropolish in isolated areas on edge.	Cutting	Flesh, bone contact	Butchery
17	Puch 2747	Distal	Unifacial dorsal scarring, specially developed on central segment of edge. Very restricted, well developed micropolish on ventral face.	Scraping	Bone	Scraping bone (defleshing?)
18	Puch 1179	Distal	Unifacial (dorsal) continuous, superimposed scars >0.3 mm. Undulating, open, rather marginal micropolish on ventral; developed micropolish inside scars on dorsal	Scraping	Non woody plant	Scraping non woody plant
19	Puch 3012	Distal	Unifacial (dorsal) scars <0.2 mm. Extended 100 μ weakly developed micropolish	Scraping	Soft material	Scraping soft material
20	Puch 3013	Distal	Bifacial scars ~0.25 mm. Well developed micropolish on scar arises, mostly ventral	Cutting	Flesh, bone contact	Butchery
21	Puch 136	Distal	Mostly dorsal scars, <0.15 mm. Invasive (~80 μ), weakly developed polish.	Scraping	Soft/medium material	Scraping soft/medium material
23	Puch 3083 303	Lateral (right)	Bifacial, crescent-shape scars. Bifacial micropolish, weakly developed.	Cutting	Soft material	Cutting soft material
24	Puch 2769	Lateral (right)	Bifacial scars <0.1 mm. Bifacial micropolish, inside scars, weakly developed.	Cutting	Soft material	Cutting soft material
25	Puch 3096 202	Distal	Unifacial, regular scars ~0.2 mm. Weakly developed polish.	Scraping	Undetermined	Scraping undetermined
26	Puch 129	Proximal (butt)	Bifacial, small scars (<0.2 mm); weakly developed polish, undulating and open pattern. Both parallel and perpendicular striae.	Mixed (cutting and scraping)	Undetermined	Cutting and scraping undetermined material
28	Puch 563	Proximal (not butt)	Continuous, unifacial (ventral) scars 0.1–0.2 mm. Weakly developed polish, mainly on dorsal.	Scraping	Medium material	Scraping medium material
29	Puch F13 578	Distal	Discontinuous, bifacial scars. Weakly developed polish, irregular microtopography and open pattern.	Undetermined	Undetermined	Used, undetermined task
32	Puch 44	Lateral (right)	Mainly dorsal small scars (0.05–0.1 mm); very poorly developed polish, marginal, on ventral face	Scraping	Undetermined	Scraping undetermined material
33	Puch 798	Proximal (not butt)	Bifacial, continuous scars, some crescent-shape, <0.5 mm; altered polish	Cutting	Soft/medium material	Cutting soft/medium material
34	Puch 2761	Distal	Mainly unifacial scars (dorsal face), developed polish with irregular microtopography (~30 μ), Rounded edge (Fig. 10a,b)	Scraping	Hide	Scraping hide
35	Puch 2226	Distal	Bifacial (mainly dorsal) scars >0.3 mm; marginal, discontinuous polish on prominent edge zones	Cutting	Flesh, bone contact	Butchery
38	Puch 4	Distal	Continuous, unifacial (ventral) scars; marginal polish, microtopography probably altered.	Scraping	Undetermined	Scraping undetermined
39	Puch 2245 2391	Distal	Bifacial and crescent-shape scars, >0.3 mm; poorly developed polish, bifacial, irregular microtopography	Cutting	Undetermined	Cutting undetermined
40	Puch 219	Distal	Continuous, bifacial (mainly dorsal) scars, 0.2–0.3 mm; well developed polish, undulating	Mixto (cutting y scraping)	Non woody plant	Cutting and scraping non woody plant

Table 4 (continued)

Number	Tool	Flake edge	Observations	Interpretation of action	Interpretation of material worked	Interpretation of activity
41	Puch 2759	Distal	microtopography, open pattern, parallel and perpendicular striae Continuous, bifacial scars >0.3 mm; marginal (~20 μ) flat-undulating polish, parallel striae	Cutting	Wood	Cutting wood
42	Puch 2754	Distal	Continuous, unifacial, small scars (~0.1 mm); marginal, discontinuous polish; slight rounding	Scraping	Medium material	Scraping medium material
43	Puch 2755	Distal	Continuous, bifacial, some crescent-shape scars, >0.3 mm; discontinuous, marginal polish, with flat microtopography	Cutting	Flesh, few bone contact	Butchery
44	Puch	Distal	Bifacial scars (but mainly dorsal) < 0.3 mm; developed polish, undulating topography, closed to open pattern, <100 μ (Fig. 12 f)	Cutting	Non woody plant	Cutting non woody plant
46	Puch 4581 1589	Proximal (butt)	Continuous, unifacial (ventral) scars; very poorly developed polish	Scraping	Undetermined	Scraping undetermined
47	Puch 2562	Distal	Few scars, micropolish in both faces, irregular topography, well developed (~80 μ). Heavy rounding (Fig. 10 c,d)	Scraping	Hide	Scraping hide
49	Puch 2760	Distal	Discontinuous unifacial scars (0.1 mm); polish on ventral face (~80 μ), undulating, closed to open pattern (Fig. 12 c,d)	Scraping	Non woody plant	Scraping on woody plant
52	Puch 33	Distal	Unifacial, continuous small scars (0.1 mm). Well developed polish with undulating-irregular topography, inside and above microscars. Rounding (Fig. 11 a,b)	Scraping	Dry hide	Scraping dry hide
54	Puch 700	Distal	Continuous, unifacial (dorsal) scars >0.5 mm; marginal developed polish, flat microtopography, compact pattern; rounding (Fig. 13 a,b,c,d)	Scraping	Hard material	Scraping hard material
55	Puch 583	Distal	Continuous, mainly dorsal scars, 0.1–0.2 mm; poorly developed, marginal polish, mainly in ventral face	Scraping	Soft material	Scraping soft material
56	Puch 3085 304	distal	Continuous, unifacial scars, <0.2 mm; poorly developed, marginal polish, mainly in ventral face	Scraping	Undetermined	Scraping undetermined material
64	Puch	Distal	Unifacial (dorsal) scars, <0.1 mm; polish mainly in ventral face, irregular microtopography, close pattern; rounding.	Scraping	Hide	Scraping hide
65	Puch 830	Distal	Discontinuous small scars on dorsal face. Rather marginal developed polish (~30 μ). Rounding (Fig. 11 c,d)	Scraping	Dry hide	Scraping dry hide
70	Puch 744	Lateral (right)	Discontinuous unifacial scars. Poorly developed polish, more extended on ventral face	Scraping	Soft/medium material	Scraping soft/medium material
78	Puch 2774	Proximal (butt)	Probably use scars on butt (some previous extractions). Poorly developed polish, extended to ~30 μ . Slight rounding.	Scraping	Soft material	Scraping soft material
81	Puch 3019	Lateral (left)	Continuous, bifacial (more on dorsal) scars, <0.2 mm. Marginal, poorly developed micropolish	Cutting	Soft/medium material	Cutting soft/medium material
87	Puch 1135	Lateral (left)	Discontinuous, bifacial scars, 0.2–0.3 mm; poorly developed polish	Cutting	Soft/medium material	Cutting soft/medium material
89	Puch 1172	Distal	Few scars; developed marginal polish on dorsal face, extensive on ventral face (~120 μ), closed to open pattern, undulating microtopography; very slight rounding (Fig. 12 a,b)	Scraping	Non woody plant	Scraping non woody plant
90	Puch 4588 1653	Distal	Continuous, unifacial scarring (on dorsal, 0.1–0.2 mm). Invasive polish inside and above scars (~150 μ), open pattern, undulating topography (Fig. 12 g)	Scraping	Non woody plant/wood	Scraping non woody plant/wood
91	Puch 2783	Distal	Discontinuous, bifacial, small scars (<0.1 mm); bifacial micropolish, rather marginal (~15 μ) with undulating-irregular microtopography	Cutting	Soft material	Cutting soft material
96	Puch 2616	Distal	Few, discontinuous, bifacial scars <0.2 mm. Bifacial, poorly developed polish, Parallel, shallow striae	Cutting	Soft material	Cutting soft material
98	Puch 4484 1161	Proximal (not butt)	Abundant small (0.1 mm) scars on dorsal face; invasive micropolish (>100 μ); slight rounding (Fig. 10 e,f)	Scraping	Hide	Scraping hide
103	Puch 251	Distal	Continuous, bifacial scars, 0.1–0.2 mm; poorly developed polish	Cutting	Soft material	Cutting soft material
109	Puch 2268 2618	Distal	Continuous, bifacial scars, <0.2 mm; marginal, poorly developed polish	Cutting	Soft material	Cutting soft material
110	Puch 91 6E 2782	Distal	Continuous, bifacial scars, 0.1–0.2 mm; poorly developed polish	Cutting	Soft material	Cutting soft material

(continued on next page)

Table 4 (continued)

Number	Tool	Flake edge	Observations	Interpretation of action	Interpretation of material worked	Interpretation of activity
111	Puch 2749	Distal	Continuous, bifacial scars (more on ventral), 0.1–0.2 mm; poorly developed polish	Cutting	Soft material	Cutting soft material
113	Puch 4599 1569	Distal	Mostly unifacial (ventral face), <0.3 mm; extended polish (~150 μ) on ventral face, open pattern, irregular microtopography; few parallel striae	Scraping	Médium material	Scraping medium material
115	Puch 217	Lateral (left)	Few bifacial scars, <0.2 mm. Extended (<200 μ) poorly developed micropolish	Cutting	Undetermined	Cutting undetermined material
117	Puch 2260	Distal	Unifacial (dorsal), continuous scars, 0.1–0.2 mm; very poorly developed polish	Scraping	Soft material	Scraping soft material
119	Puch 2776	Distal	Bifacial, continuous scars, <0.3 mm; bifacial polish (~60 μ), open pattern, undulating microtopography; shallow perpendicular striae	Cutting	Wood	Cutting wood
120	Puch 4030 1345	Distal	Unifacial (dorsal) scarce scars, <0.2 mm; mainly unifacial (dorsal) polish (~40 μ) open pattern, undulating-irregular microtopography	Scraping	Non woody plant/wood	Scraping non woody plant/wood
121	Puch 1346 4474	Distal	Continuous mainly unifacial (dorsal) scars, 0.2–0.3 mm; developed polish, undulating microtopography, closed to open pattern (Fig. 12 e)	Scraping	Non woody plant/wood	Scraping non woody plant/wood
122	Puch 866	Distal	Continuous bifacial scars, 0.1–0.2 mm. Bifacial, poorly developed polish in protruding areas on edge	Cutting	Flesh, bone contact	Butchery
123	Puch 2262 1551	Distal	Continuous bifacial scars (0.2 mm). Discontinuous, marginal, flat, compact pattern polish on edge, more open inside face (Fig. 9 a,b,c)	Cutting	Flesh, bone contact	Butchery
124	Puch 4241 193	Distal	Unifacial (dorsal) continuous scars, <0.5 mm. Marginal, poorly developed polish in both faces, sometimes inside scars	Scraping	Hard material	Scraping hard material
125	Puch 3012 1552	Distal	Unifacial (dorsal) continuous scars, <0.4 mm. Marginal, discontinuous polish mainly on ventral	Scraping	Hard material	Scraping hard material
126	Puch 3021 267	Distal	Bifacial, continuous scars, <0.3 mm; bifacial, discontinuous polish with compact pattern and flat microtopography. Isolated striae, parallel	Cutting	Flesh, bone contact	Butchery
128	Puch 3017 289	Lateral (right)	Unifacial (dorsal) scars <0.3 mm; marginal micropolish more extended on dorsal (~15 μ), nearly closed pattern and undulating microtopography	Scraping	Wood	Scraping wood
129	Puch 9009 2281	Distal	Unifacial (dorsal) scars <0.5 mm; marginal, continuous (in segments) micropolish mainly in ventral face, flat microtopography and compact pattern	Scraping	Bone	Scraping bone
130	Puch 4027 291	Distal	Bifacial (mainly dorsal), continuous scars, <0.4 mm, some crescent-shape; isolated areas of polish with compact pattern and flat microtopography (mainly on ventral)	Cutting	Flesh, bone contact	Butchery
131	Puch 4027 288	Distal	Unifacial (dorsal), continuous, superimposed scars, <0.4 mm; marginal, poorly developed polish on ventral	Scraping	Medium material	Scraping medium material
133	Puch 4027 290	Distal	Unifacial (dorsal) scars <0.3 mm; marginal micropolish more extended on dorsal (~15 μ), nearly closed pattern and undulating microtopography	Scraping	Wood	Scraping wood

117 artifacts (60%) preserved use-wear traces on one or more edges (Tables 3 and 4). There is only one flake with two used edges, therefore totaling 71 utilized areas (Tables 3 and 4). The non-taphonomic character of traces is evidenced by close combination of micropolishes, microscars –and sometimes rounding–consistent with use-wear patterns, together with the recurrent location of traces on the distal edges combined with the absence of traces on the other edges and arrises of the flakes. Four main results proceed from our use-wear analysis: (1) the systematic selection of distal edges on flakes as active zones and a preferential selection of large-size blanks, (2) the wide range of worked materials and the presence among them of hide, wood and non-woody materials, (3) the significance of scraping tasks, and (4) the low intensity of traces on the working edges.

1 Large flakes are preferentially selected for use (Fig. 5 Student's *t*-test used vs unused $p = 0.00079$ for width; $p = 0.0086$ for length). The most influential metric dimension is width, which seems logical considering that a greater width implies a longer distal edge, the usual active area. The distal edge is the working area in nearly 80% of the flakes with use-wear traces (55/69). Le Pucheuil-type flakes have regular, sharp (c. 40°), straight or slightly convex distal edges, which are clearly delimited with a marked end in relation with the lateral edges.

Lateral edges are much more rarely used ($n = 9$), as are the proximal edges at the intersection of the butt and the dorsal face ($n = 6$). Two flakes exhibit tiny removals on their butt which may be the result of a flake transformation, of a previous retouch on the

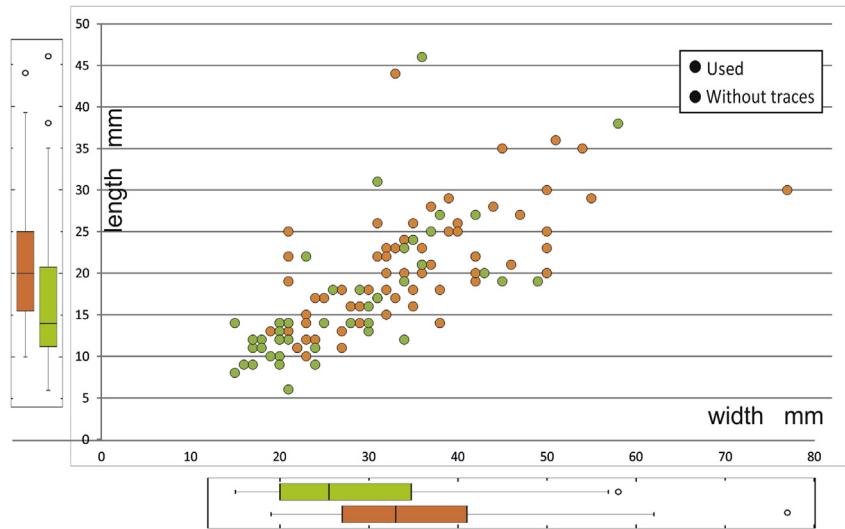


Fig. 5. Length vs. width for used Le Pucheuil-type flakes used vs. flakes without traces. Left and bottom, box and whisker plot for length and width.

core edge or of the preparation of the platform prior to flaking. In any case, a proximal use is rather marginal as it involves only 8% of the flakes.

Use evidence of Le Pucheuil-type cores is nearly absent. Only one of the four analyzed cores displays very slight traces in a zone less than 1 cm long that may relate to an expedient use. The core edges remnants in Le Pucheuil flakes were systematically observed and never bore use wear traces. This indicates that Le Pucheuil-type cores were used for a single purpose: the production of flakes.

Scraping and cutting activities are slightly differently located on the distal edge of the flakes, as a polar-spider plot shows (Fig. 6). Both scraping and cutting develop a cardioid pattern which implies a clear selection of the position of the working edge. However, scraping tasks are more limited to the central part of the distal edge (zones 7 to 10, Fig. 7). It is not possible to determine whether the proximal, prehensile part, was hafted or hand-held due to the absence of reliable traces, but the fact that the working areas related to scraping motions are centered on the distal edges might suggest a hafting device (Rots, 2010).

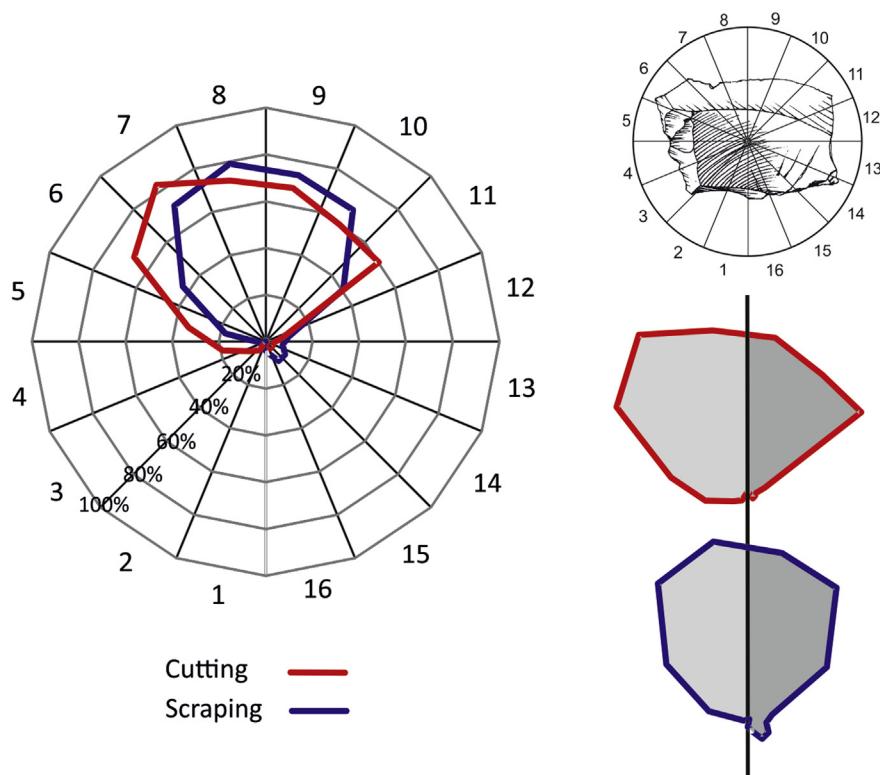


Fig. 6. Polar-spider plot showing the location of working edges in Le Pucheuil-type flakes. 1,16, proximal zone; 4,5 left lateral; 7,8, distal; 12,13, right lateral (see top right scheme for a Le Pucheuil-type flake). Bottom right: red outline, distribution of cutting activities, blue outline, distribution of scraping activities. See more lateralized distribution of cutting activities, larger area to the left of the bisecting black line. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

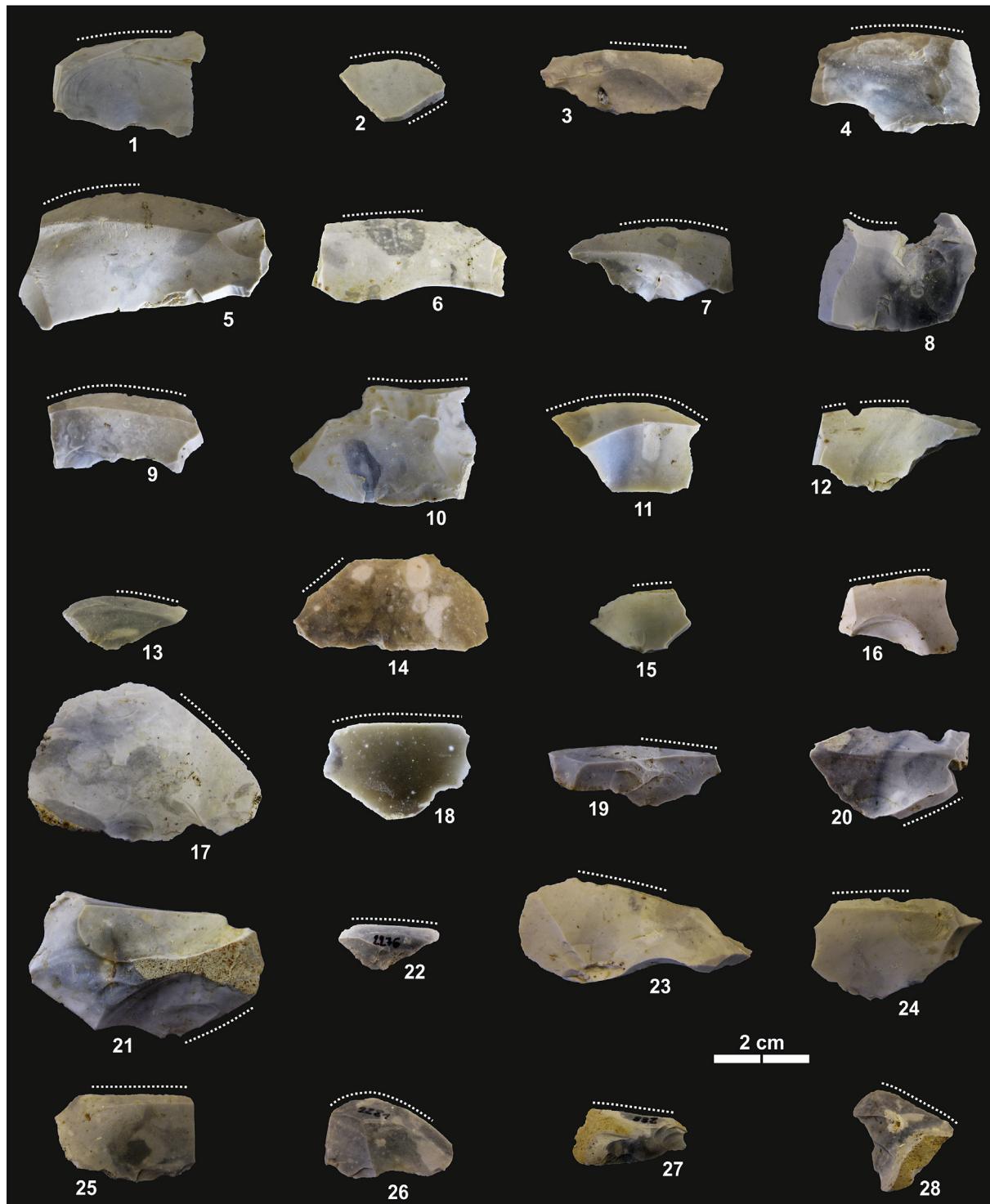


Fig. 7. Le Pucheuil type flakes used for scraping activities with indication of the active area.

Cutting use-wear traces are more extensive (zones 6 to 11, Fig. 8), as a result of the fact that the portions of edge employed for cutting are longer than those used for scraping (31 vs. 22 mm, cf. Beyries, 1993). The longest edges are those used for butchery. The location of active zones also shows that cutting activities are significantly lateralized on the left part of the flake in dorsal view (Fig. 6). Lateralized movement produces an asymmetrical distribution of traces in frontal view (González-Urquijo and Ibáñez,

1994). It is more likely to occur when cutting soft materials than when sawing harder ones because of the type of motion (unidirectional vs. bidirectional), and for hand-held tools compared to hafted ones.

2 Le Pucheuil-type flakes worked a wide range of materials: animal carcasses as part of butchery tasks, hide, wood, non-woody plants and osseous materials as part of one-off

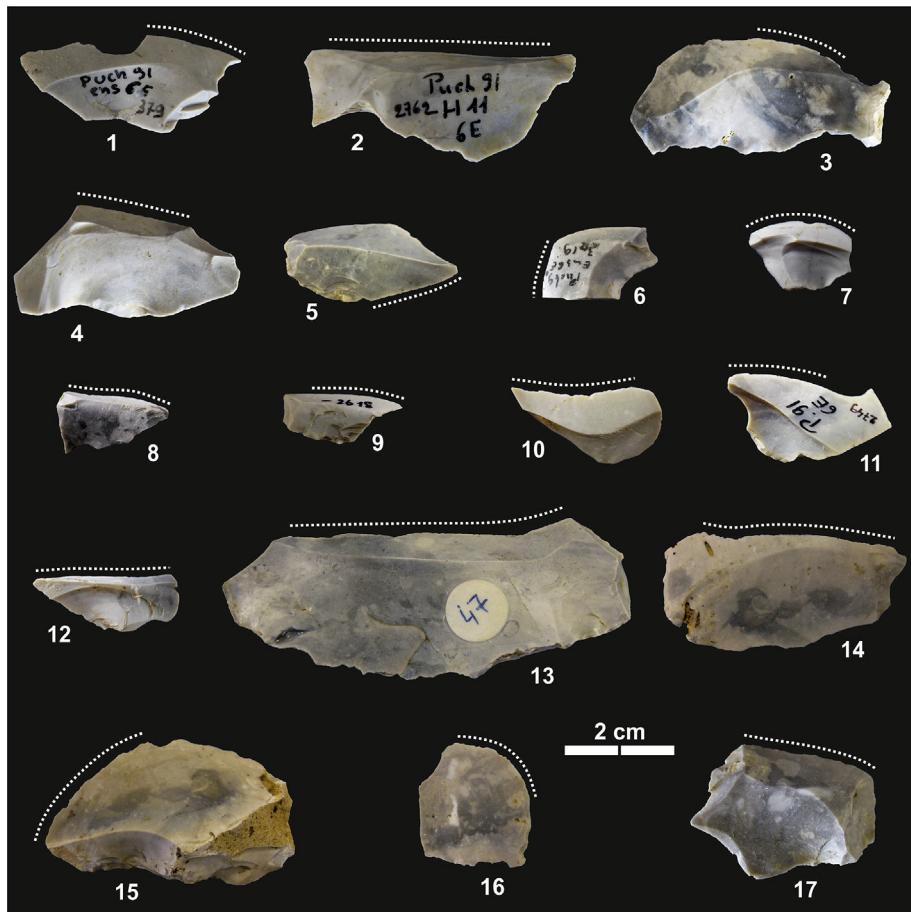


Fig. 8. Le Pucheuil type flakes used for cutting activities with indication of the active area.

scraping activities (Table 2). The diversity of tasks is also seen in the range of activities performed with flakes from the same core. They are used in activities as diverse as wood scraping and butchery (refit 8), or hard material scraping and butchery (refit

93). It has not been possible to make a precise assessment for 17% (12/71) of the utilized edges because of the weak development or alteration of the traces. On another 35% (25/71), the assessment has been limited to the relative hardness of the

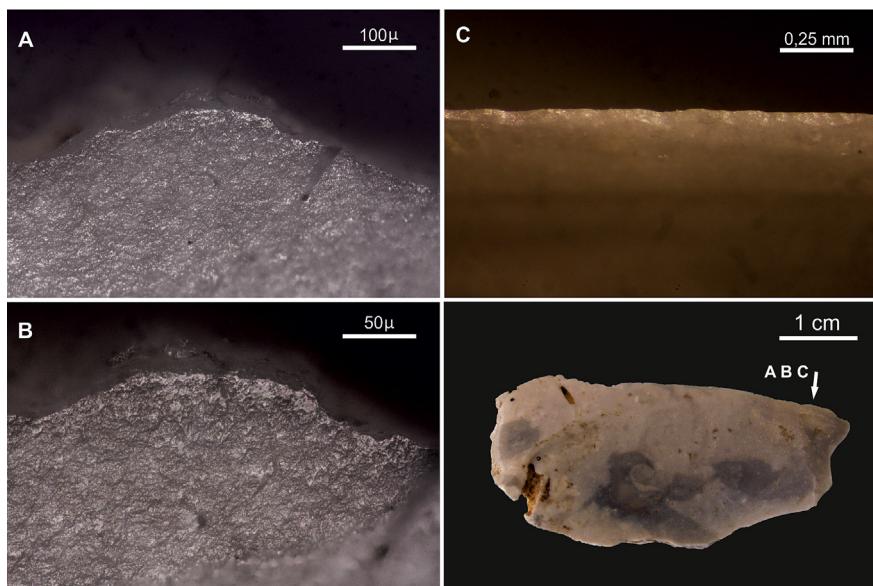


Fig. 9. Butchery traces. Left, polish with compact reticulation and linear components parallel to the edge. Incident light microscope A, 100 \times , B, 200 \times . Top right, small continuous microscarring in nearly apical view, Macroscope 40 \times . Bottom right position of the photographed zones in the working edge.

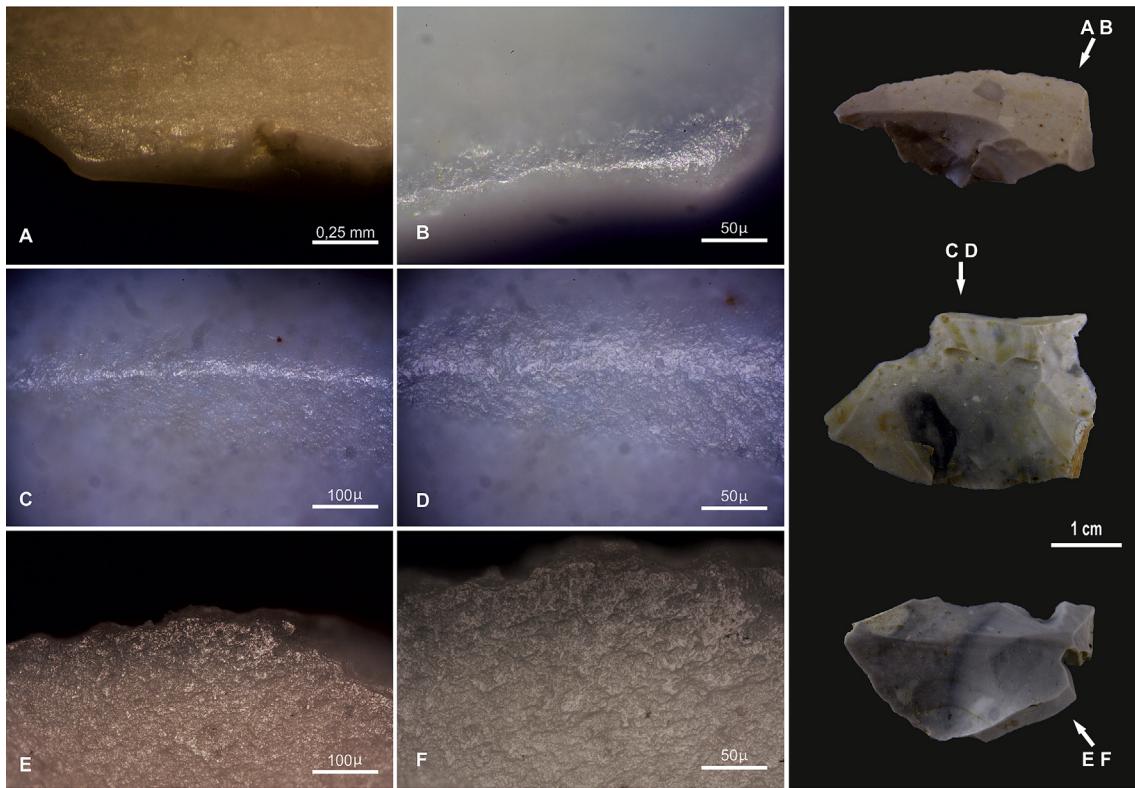


Fig. 10. Hide working use-wear. Top: rounding (A) and detail of rounding and associated polish (B). Macroscope, A, 40×; Incident light microscope, B, 200×. Middle, rounding and associated polish (C, D), Incident light microscope, C, 100×; D, 200×. Bottom: weakly developed polish and incipient rounding. Incident light microscope, E, 100×; F, 200×. Right, position of the photographed zones on the working edges.

worked material. Cutting soft materials is the prevailing task in this category.

The whole range of work on animal material -hide, butchery, bone-equals 28% (20/71). Butchery traces, especially microscars, are not very intense in terms of frequency and size (Fig. 9). This suggests that flakes were used more for defleshing than for the

first phases of animal dismembering (Ibáñez and González Urquijo, 1996). Evidence of bone scraping in this context, with diminutive active zones (mean 16 mm) and weakly developed micropolish, must be related to the defleshing and superficial cleaning of bones rather than to the elaboration of bone products. The evidence of hide working in dry condition is noteworthy (Figs. 10 and 11).

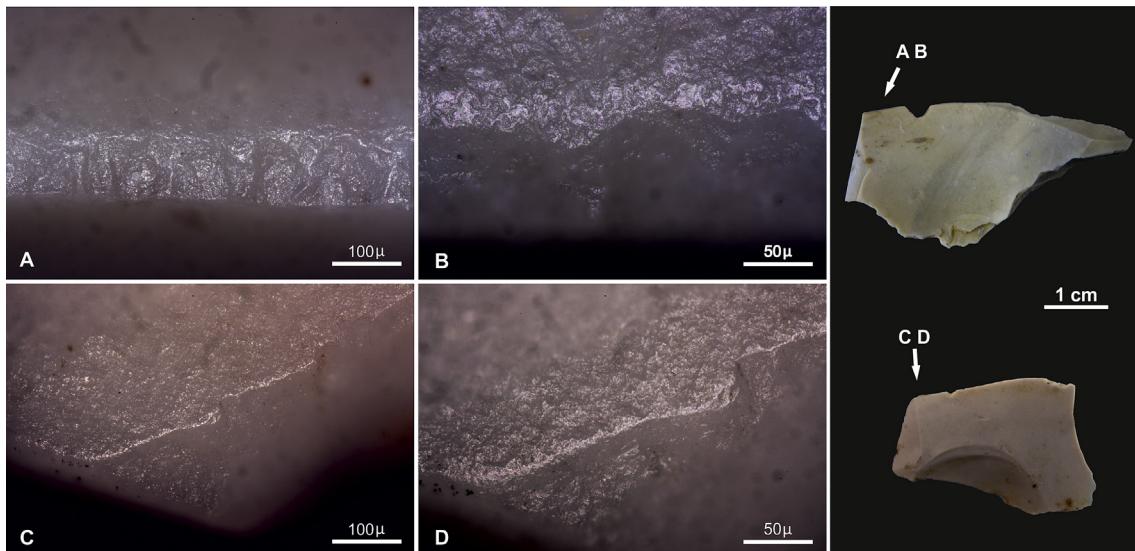


Fig. 11. Dry hide working use-wear. Top: distribution of use-wear polish inside (A) and above (B) dorsal microscars in the same area, changing slightly the orientation of the working edge. Incident light microscope A, 100×, B, 200×. Bottom: polish and micro-rounding of the working area. Incident light microscope C, 100×; D, 200×. Right, position of the photographed zones on the working edges.

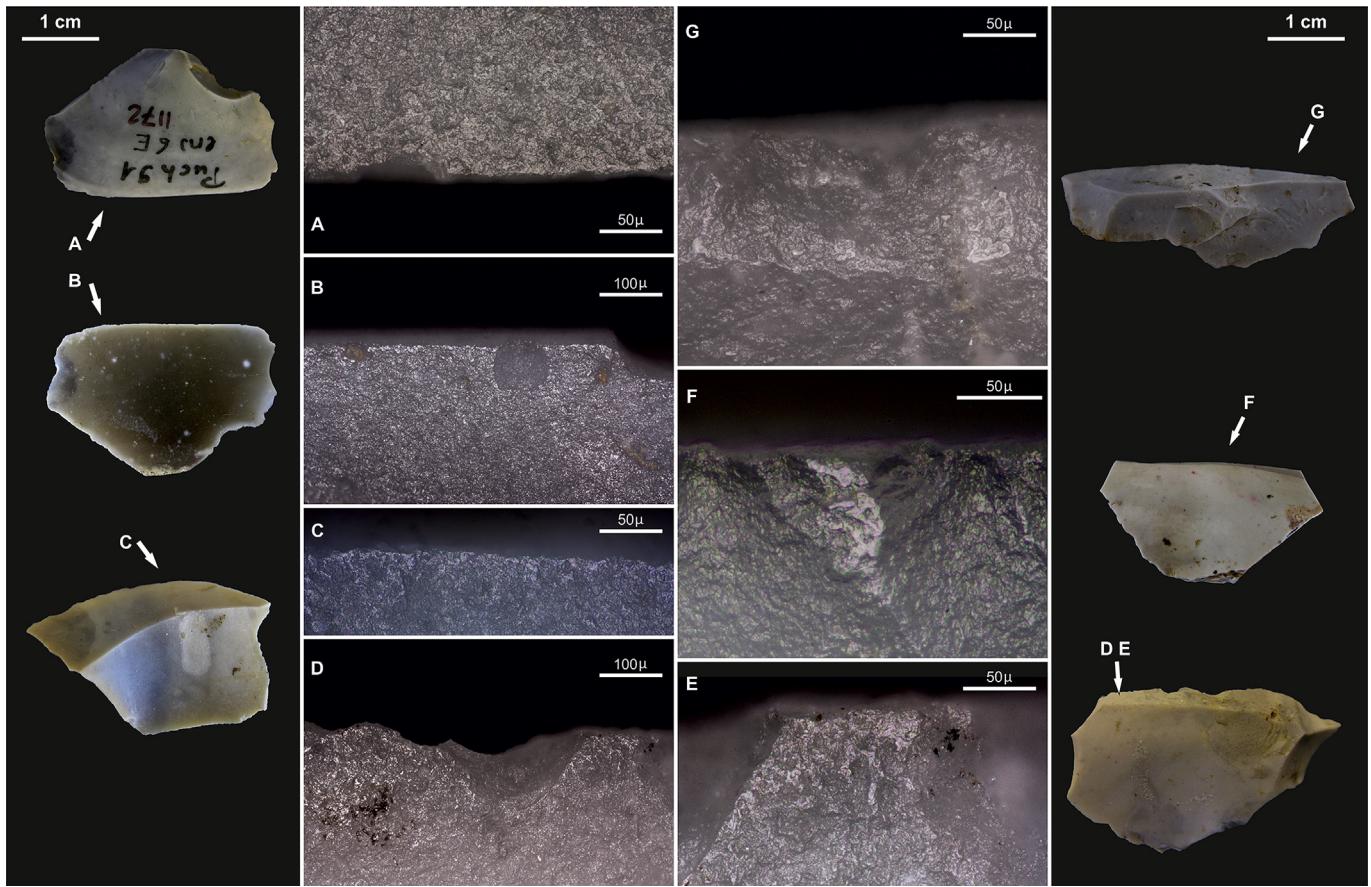


Fig. 12. Woody and non-woody plants use-wear. Location of traces (A & B), mainly polish, on both faces of the same working edge. Incident light microscope A, 200×, B, 100×. Association of polish to microscars (C, F & G) in scraping and cutting motions. Incident light microscope, 200×. Scraping traces (D & E). Incident light microscope D, 100×, E, 200×. Left and right, position of the photographed zones on the working edges.

Wood and non-woody plants account for up to nearly 20% (14/71) of the used edges (Fig. 12). Non-woody plant working is especially related with scraping motions.

The other tools cannot be precisely assessed (51.3%). Those interpreted as tools used with medium hardness material may be associated with woodworking, rigid non-woody plants or, less likely, with dry hide working, in the early stages of work before the development of micro-rounding. Soft materials can be linked with fresh hide, light butchery or flexible non-woody plants.

3. Scraping motion (Fig. 13) on a wide range of materials accounts for more than 60% (44/71) of the observed activities. As noted above, edges used for scraping are shorter and more centered than those used for cutting. There is also a slight but significant difference in the edge angle. The average cutting angle is 35.6° while scraping edges increase to 44.8° (Student's test $p = 0.014$) which means a certain selection of blank edges for particular use motions. The frequency of scraping motion implies that Le Pucheuil-type flakes differ from the prevailing view which

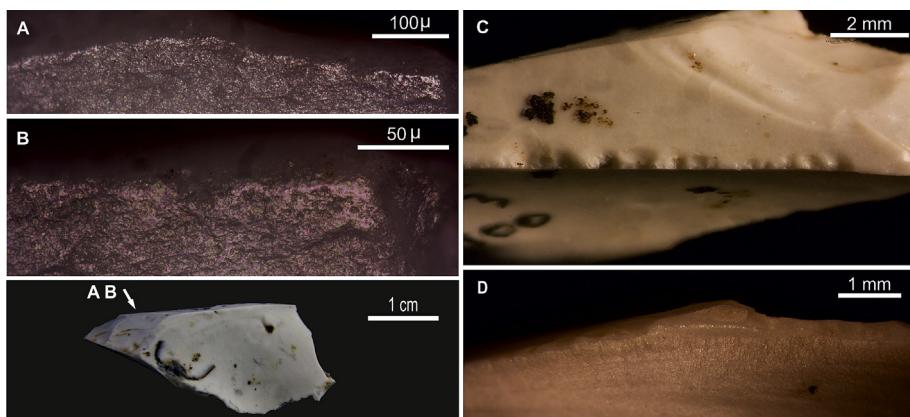


Fig. 13. Hard undetermined material scraping use-wear. Distribution of polish and rounding (A & B) on the ventral face. Incident light microscope A, 100×, B, 200×. Scarring on the dorsal surface (C) and rounding –in the center of the image–view from the ventral face. Macroscopic, C, 6×, D, 10×.

- states that unretouched flakes are most commonly used in cutting activities (Beyries, 1987; Geneste and Plisson, 1996; Bosquet et al., 2004). Scraping tasks focused on wood, non-woody plants and hide, whether fresh or dry. Scraping motion acts as a good indicator of raw material transformation processes. In the case of soft organic materials there is usually no other evidence in most archeological contexts.
4. Intensity of tool use is quite low. All the evidences in the use-wear traces and in the management of the tools points to non-intensive activities: (a) multiple tasks on the same flake are not documented, with only one exception, (b) there is no evidence of resharpening, (c) trace development is discrete which generally implies a short working time, (d) the active edges are short, a trait related with the work of non-massive materials. All these observations point to single-use tools, devoted to the end of the technical processes, and related either to maintenance or repair.
- ## 5. Discussion
- Le Pucheuil-type *débitage* consists of a combination of technical rules that result in flakes with recurring morpho-functional attributes. Such attributes are an elongated sharp (30–40°) and slightly curved or straight distal edge that forms the active working edge, opposed to a wide and robust proximal part with a marked concavity in profile, which forms an opposite back used as prehensile area.
- The use-wear analysis of Le Pucheuil-type flakes confirms that these flakes form the intentional end-products of a secondary reduction sequence and are not the by-products of a tool rejuvenation or recycling process: use traces have been identified on a large majority of Le Pucheuil-type flakes while the cores are only waste products. This production is part of a dendritic *chaîne opératoire* where several types of blanks proceed from varied primary or secondary reduction sequences. The absence of blank transformation, together with the low intensity of traces, all related on the same blank to a single use phase, point to a production of single-purpose tools, i.e. predetermined and short use-life products designed to be used exclusively as tools (Delagnes, 2010; Delagnes and Rendu, 2011). Each type of blank might have fulfilled diverse needs. Both the worked materials (butchery, hide, wood, and non-woody plants) and the activities (cutting and scraping) involved in the use of Le Pucheuil-type flakes are varied. Some more subtle variations also appear in the exploitation of the working edges which are sharper, longer and lateralized for cutting while stronger, shorter and centered for scraping activities. Other case studies have also demonstrated that Levallois points, which form another type of single-purpose tool, were used for various tasks (Plisson and Beyries, 1998; Locht, 2002; Vallin et al., 2006; Lazuén et al., 2011). Technologies based on single-purpose reduction sequences, are most commonly documented during the early stages of the Middle Paleolithic in western Europe (Delagnes and Meignen, 2006; Delagnes and Rendu, 2011).
- Butchery tasks account for a significant part of the activities carried out with Le Pucheuil-type flakes. The use of small unmodified flakes for butchery tasks, even for processing large animal carcasses, is observed in a number of early Paleolithic sites (Ollé, 2003; Barkai et al., 2010), and it is also usually accomplished with unretouched tools during the early Middle Paleolithic (i.e. Geneste and Plisson, 1996; Bosquet et al., 2004; Vallin et al., 2006; Terradas and Clemente, 2011). At Le Pucheuil, the characteristics of butchery traces (small size and low frequency of microscars) point to a secondary butchery, focused on defleshing, with few traumatic contacts with the hardest parts of animal carcasses. This butchery phase has been reported in varied Paleolithic contexts. It is related either to carcass cleaning, meat preparation or fleshy tissue consumption, using small tools with sharp cutting edges (Geneste and Plisson, 1996; Roebroeks et al., 1997; Stiner et al., 2009; Barkai et al., 2010; Claud et al., 2012; Lazuén and González-Urquijo, in press). In some cases, multiple evidence from tool types and sizes, use-wear traces and butchery marks on faunal remains makes it possible to discriminate between individual and collective functioning of butchery knives (Stiner et al., 2009; Barkai et al., 2010; Rots, 2013). At Le Pucheuil, this issue cannot be directly addressed due to the absence of faunal remains.
- However, the bulk of the activities carried out with Le Pucheuil-type flakes is the manufacturing or repair of hide, wood and non-woody plants. These tasks share common traits, which are the importance of scraping compared to cutting tasks, the low energy involved in tool use and the limited length of the working edges. This combination of traits relates to the final phases of the production and maintenance of goods: fine adjustments, finishing or repair tasks.
- Dry hide transformation is scarcely documented for the older phases of the Middle Paleolithic and remains unusual during the more recent phases (González-Urquijo and Lazuén, 2013). Hide working in hunter-gatherer societies is a rather complex technical process (Lemorini, 1999; Beyries et al., 2002; Weedman-Arthur, 2008). Hide processing is time-consuming as it requires several successive manufacturing and maintenance steps. It also usually implies spatial and temporal breaks, substantial energy, tool and manpower costs, a high degree of group organization and task planning. The reality of hide processing by Neanderthal groups is a matter of debate (Stiner and Kuhn, 2009; Lazuén, 2012a; Soressi et al., 2013). It is nevertheless consistently evidenced by use-wear analyses that this technology was in use throughout the European Middle Paleolithic (Beyries, 1987, 1988; Lemorini, 2000; Cortés et al., 2010; Lazuén et al., 2011; Lazuén, 2012a), maybe with less sophisticated methods compared to the Upper Paleolithic. In this respect, the activities identified at Le Pucheuil are of low intensity and developed on restricted areas of the working edges. It suggests the production or maintenance either of small hide products or of small portions of larger pieces.
- Woodworking is frequent in Middle Paleolithic sites (Beyries, 1987; Schelinski, 1993; Lemorini, 2000; Rodríguez et al., 2002; Bosquet et al., 2004; Cortés et al., 2010; Terradas and Clemente, 2011; Lazuén et al., 2011; Rots, 2013), and preserved wooden implements, although scarce, are also documented for this time period (Carbonell and Castro-Curel, 1992; Thieme, 1997). Conversely, non-woody plant work is not very common in Paleolithic contexts, even in Upper Paleolithic sites. Evidence of the utilization of non-woody plants during the Early Middle Paleolithic comes from the use-wear analyses carried out at Vaufrey level VIII, Les Tares, Lezetxiki V, Axlor R and Qesem (Beyries, 1987; Geneste and Plisson, 1996; Lazuén and Altuna, 2012; Lazuén and González-Urquijo, in press; Lemorini et al., in press), dated from OIS 7 to OIS 5. In the more recent Middle Paleolithic sites of La Combette, La Folie and Bajondillo, non-woody plant processing would have been related to intentional gathering, by cutting (Lemorini, 2000; Bourguignon et al., 2002; Gibaja, 2007; Cortés et al., 2010). In La Combette level D, Lemorini correlates these harvesting tasks with technological activities (e.g. bedding, fiber-made containers), based on ethnographic references (Harlan, 1992). In Le Pucheuil B, non-woody plant processing was based on scraping tasks. This is also the case in a few other sites, always with a limited number of tools used on plants (Cortés et al., 2010; Lazuén and Altuna, 2012; Lazuén and González-Urquijo, in press). Evidences of plant use for subsistence and fuel are now well established thanks to calculus (Henry et al., 2011) and phytolith

analyses (Albert et al., 2000). The latter have also shown the use of grasses for bedding (Cabanes et al., 2010).

The Pucheuil-type production may well be included within flake types that are usually described as expedient on the basis of the low investment in core preparation and management, the absence of flake modification and the variety of tasks they responded to. However, our global and integrated techno-functional analysis reveals unexpected behavioral complexity beyond the apparent simplicity. The complexity stems first from the whole structure of the lithic production, involving a dendritic *chaîne opératoire* with primary and secondary productions resulting in distinct specific end-products. The recurring morpho-functional attributes of the Pucheuil-type flakes are correlated with constant prehension and gesture patterns applied to the final stages of the preparation of goods. Predetermination is not governed here by strict stylistic or size requirements nor by specific tasks, but it rather relates to tool functioning, i.e. the way in which the tool was used (Sigaut, 1991) in relation with the careful finishing or maintenance of varied goods. These simple tools were thus clearly part of a complex technology (Golson, 1977).

The variety of worked materials and the related stages of transformation point to a significant time depth in Le Pucheuil site occupation. The association of butchery, hide working, wood and non-woody plant transformation relates to a range of complementary activities that were likely performed as part of durable and multi-activity occupations. Time-depth is also indicated by the evidence of hide processing which involves a number of technical steps and a high degree of social organization. The Pucheuil B assemblage finally reflects the advanced adaptation of the early Middle Paleolithic groups to harsh environments, such as the Pays de Caux: a chalky plateau totally devoid of natural shelters. The installation of a living place in such an environment probably implies the existence of efficient personal or site protection against the weather. The association of diverse subsistence and transformative activities in combination with a single-purpose technology, suggests a dwelling site used for a wide range of activities radiating around the site within a foraging strategy (Delagnes and Rendu, 2011). It ultimately shows the high behavioral adaptability of the Neanderthal groups who occupied the loessic plains of northern Europe during the early Middle Paleolithic.

6. Conclusion

In the context of the European Middle Paleolithic, the characteristics of Le Pucheuil-type production are quite unique, both technologically and functionally. This secondary production was used to make tools with predetermined attributes related to tool functioning. Here tool functioning is based on an elongated transversal sharp working edge opposed to a wide proximal prehensile area. While the production of predetermined flakes is a widespread trait of the early Middle Paleolithic (Delagnes and Meignen, 2006; Richter, 2011), it is most commonly assumed that these products correspond to curated and mobile tools (Féblot-Augustins, 1999; Geneste, 1985; Roebroeks et al., 1988). This is not the case of Le Pucheuil-type flakes, which were produced and used on-site from locally available flint. This production adds a further element to the emerging picture of Neanderthal behavioral flexibility and innovative abilities (Delagnes and Rendu, 2011; Turq et al., 2013), reflected in the diversity of flaking methods and concepts that co-existed during the early stages of the Middle Paleolithic.

Le Pucheuil-type flakes participated in a variety of tasks, from subsistence activities (i.e. animal butchery) to the technological transformation of varied materials, such as hide, wood and non-woody plants, by cutting and scraping. This wide array of activities is related to the last phases of goods production and

maintenance. The nature and variety of these tasks imply a certain degree of task planning and a long-lasting site occupation, as opposed to more contingent site occupations characterized by specialized toolkits (Geneste and Plisson, 1996). Such patterns relate to a structured spatial and temporal management of resources as part of a foraging economic system radiating around the site. This site function, often seen as characteristic of cave occupations (Beyries, 1987; Terradas and Clemente, 2011), shows that the Neanderthal groups who settled in the loess regions of north-western Europe developed a social organization similar to that observed in more favorable environments.

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